

4. "On the Powers on which the Functions of Life depend in the more perfect Animals, and on the Manner in which these Powers are associated in their more complicated results." By A. P. W. Philip, M.D., F.R.S.

This paper is divisible into three portions. In the first, the author considers the functions and seat of each of the powers of the living animal; in the second, the nature of each power; and in the third, the manner in which they are associated in the more complicated results which constitute life.

Of these powers the simplest is the muscular, which consists merely in a contractile power residing in the muscular fibre itself: and various experiments are referred to in proof that it depends exclusively on the state of this fibre, and in no degree on that of the nervous system, which some physiologists have regarded as the real seat of this power: for, instead of being recruited, it is exhausted by the action of the nervous system upon it, as it is by other stimulants.

The next power considered is that of the nervous system, properly so called, in contradistinction to the sensorial system. The result of an extensive series of experiments made with a view to establish the exact line of distinction between these two systems, is that the functions of the nervous power are as remarkable for their complexity as that of the muscular power is for its simplicity. With regard to the nervous power it is shown that its functions (all of which are capable of existing after the sensorial power is withdrawn, and all of which fail when the nervous power is withdrawn,) are the following: 1. The excitement of the muscles of voluntary motion in all their actions; 2. The occasional excitement of the muscles of involuntary motion; 3. The maintenance of the process by which animal temperature is maintained; 4. The maintenance of the various processes of secretion; 5. The maintenance of the processes of assimilation. It farther appears, from several experiments, that the seat of the nervous power is exclusively in the brain and spinal cord; not, however, in any particular part, but in the whole extent of these organs, from the uppermost surface of the former to the lowest portion of the latter; with the exception only that the lower portions of the spinal cord partake less of this power than the rest. It appears also that the nerves are only the medium of conveying the influence of the above-mentioned organs; and their ganglions and plexuses are only the means of combining the power of all the parts of these organs; such combination being shown to be necessary to the due excitement of the muscles of involuntary motion, and for the maintenance of the functions of secretion and assimilation.

The remaining powers of the living animal are the sensorial powers, and the powers of the living blood. The first of these classes of powers has its seat, not in the whole brain and spinal cord, as is the case with the nervous power, properly so called, but in certain parts of them; these parts being, in man, almost wholly confined to the brain; while in some animals they extend also to a considerable portion of the spinal cord. The functions of the sensorial powers are those strictly termed mental, of which sensation and volition are the simplest, and

the only powers of this class which are concerned in the maintenance of life.

The functions of the living blood are evidently those of supplying the proper materials, in their requisite condition, (to the preservation of which the vital powers are essential,) for the action of the nervous power, properly so called, in the processes of secretion and assimilation. The seat of the powers of the blood is in itself; as appears from its retaining them for a short time after it is separated from the body.

These four vital powers, viz. the muscular, the nervous, the sensorial, and that of living blood, have no direct dependence on one another; for each can, for however short a time, exist independently of the others: but each has an indirect dependence, more or less remote, on all the other three for the maintenance of their organs.

The author then proceeds to inquire into the nature of these several powers. The sensorial and muscular powers, and the powers of the living blood, are manifestly peculiar to the living animal, no analogous powers being perceptible in inanimate nature. But this exclusiveness does not belong to the nervous power, for experiment shows us that when the oxygen and carbon of the blood are combined by its influence, a substance results which is identical with that produced in the laboratory of the chemist. An analogy, too strong to be wholly disregarded, exists therefore between its effects and those of the powers which operate in inorganic nature. This consideration, as well as others stated by the author, induced him to make many experiments to determine how far the other functions of the nervous influence bear a similar analogy to the operations of inanimate nature; and, in particular, to inquire whether voltaic electricity, applied under the same circumstances as those under which the nervous influence operates, and applied after the removal of that influence, and the consequent cessation of its functions, would produce the same effects. His endeavours were crowned with complete success; all the functions of the nervous power being capable, as far as he and others could judge, of being perfectly performed by voltaic electricity. He states that the results of his experiments on this subject were confirmed by a public repetition of them both in London and in Paris; as were likewise those of another set of experiments suggested by the following reasoning. If the nervous influence could be made to pass through any other conductor than the nervous textures to which it belongs in the living animal, we should have a proof, independent of all other evidence, that this influence is not a vital power, properly so called; because it must be universally admitted that such a power can exist only in the texture to which it belongs. In this attempt he was for some time baffled; but at length, overcoming the obstacles which had impeded his efforts, he succeeded: and, having undergone the same public ordeal as the former, the results are no longer questioned. From the whole of these experiments the author thinks himself warranted in concluding that the nervous influence is not a vital power, properly so called; and that when it is admitted that voltaic electricity is capable of performing all its functions, the proposition that they

are powers of a different nature would be a contradiction in terms, for it is only by its properties that any principle of action can be distinguished.

He refers, in confirmation of these inferences, to the recent investigations of Mr. Faraday, from which it appears that electricity is the agent in all chemical processes ; to the facts which prove that all the functions of the nervous influence, properly so called, are of a chemical nature ; and also to the late experiments of Dr. Davy on the Torpedo, tending to show that the electric power, peculiar to electric animals, is a function of the brain, and thus affording direct proof that the brain has the power of collecting and applying, even according to the dictates of the will, the electric power.

It farther appears, from the facts referred to in this paper, that, whenever we can trace any analogy between the functions of the living animal and the operations of inanimate nature, an agent belonging to the external world is employed ; that these functions are the results either of such agents acting on vital parts, or of vital parts acting on them ; and that the sensorial functions, on the other hand, in which no such analogy can be traced, are the effects of vital parts acting on each other, and influencing each other by their vital properties alone.

In the concluding part of the paper the author considers the various functions of the living animal as forming two systems, in a great measure distinct from one another, in each of which all its powers are employed, but in very different ways : the object of the one of these systems being the maintenance of the body itself; of the other, the maintenance of its intercourse with the external world. The manner in which the different powers of the living animal are employed in the construction of each of these systems is pointed out ; and the bonds of union which exist between them, and thus form the living body into a whole, no part of which can be affected without tending more or less to affect every other, are considered. These bonds of union consist chiefly in the employment of the same powers in the construction of both systems, and in the function of respiration, which so extensively influences all other functions both in health and disease, as pointed out by the author in his papers on the nature of sleep and death, and which differs from all the other vital functions in partaking of the sensorial as well as of all the other powers of the living animal.

##### 5. "On the Respiration of Insects." By George Newport, Esq. Communicated by P. M. Roget, M.D., Sec. R.S.

Although a multitude of facts has been collected relating to the physiology of respiration in insects, attention has seldom been directed to the variations exhibited in this function in the different periods of their existence. The author gives an account, in this paper, of the anatomical and physiological peculiarities which he has noticed in various insects, in their three states of larva, pupa, and imago. He traces all the several changes which the tracheæ and spiracles undergo during their transformations ; describing particularly the successive development of the air vesicles in connexion with the power of flight.